



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : G02C 7/02, 7/04, 7/06	A1	(11) International Publication Number: WO 89/11672 (43) International Publication Date: 30 November 1989 (30.11.89)
(21) International Application Number: PCT/IT89/00033 (22) International Filing Date: 8 May 1989 (08.05.89) (30) Priority data: 20707 A/88 24 May 1988 (24.05.88) IT (71)(72) Applicant and Inventor: GIOVANZANA, Mario [IT/IT]; Via Cherubini, 6, I-20123 Milano (IT). (74) Agents: AIMI, Luciano et al.; Società Italiana Brevetti, Via Carducci, 8, I-20123 Milano (IT). (81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), SU,		US. Published <i>With international search report.</i>
(54) Title: A PROGRESSIVE ECCENTRICITY MULTIFOCAL CONTACT LENS AND MANUFACTURING PROCESS THEREOF		
<div data-bbox="168 1245 308 1272" data-label="Section-Header">(57) Abstract</div> <div data-bbox="168 1293 828 1524" data-label="Text"> <p>A multifocal contact lens, having progressive eccentricity in an area coaxial relative to the optical center, is obtained through the lens outer surface turning on a lathe, in the optical area involved, by means of a computer controlled lathe, based on special computer programs. The contact lens provided as said above allows vision problems concerning both far range vision and near range vision, in miopic or hypermetropic subjects, to be simultaneously corrected.</p> </div> <div data-bbox="873 1163 1429 2045" data-label="Image"> </div>		

BEST AVAILABLE COPY

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FI	Finland	ML	Mali
AU	Australia	FR	France	MR	Mauntania
BB	Barbados	GA	Gabon	MW	Malawi
BE	Belgium	GB	United Kingdom	NL	Netherlands
BF	Burkina Fasso	HU	Hungary	NO	Norway
BG	Bulgaria	IT	Italy	RO	Romania
BJ	Benin	JP	Japan	SD	Sudan
BR	Brazil	KP	Democratic People's Republic of Korea	SE	Sweden
CF	Central African Republic	KR	Republic of Korea	SN	Senegal
CG	Congo	LI	Liechtenstein	SU	Soviet Union
CH	Switzerland	LK	Sri Lanka	TD	Chad
CM	Cameroon	LU	Luxembourg	TG	Togo
DE	Germany, Federal Republic of	MC	Monaco	US	United States of America
DK	Denmark	MG	Madagascar		
ES	Spain				

" A PROGRESSIVE ECCENTRICITY MULTIFOCAL CONTACT LENS AND
MANUFACTURING PROCESS THEREOF "

This invention concerns contact lenses adapted to ensure correction, through a single dioptric means, for
5 both visual defects related to far range vision (miopia and hypermetropia), and visual defects related to near range vision (presbyopia).

Furthermore, this invention concerns the process for manufacturing said contact lenses, through use of any
10 type of lathe, both numerically controlled and "duplicating" lathe, controlled by a computer or electronic data processing equipment, according to special process computer programs. As it is already known, in the lenses for conventional glasses, the possibility to see
15 correctly both in the near distance range and in the far distance range, is provided by dividing said lenses in two parts, wherein the upper part enables far range vision while the lower part enables near range vision, owing to the eye motions relative to the lens. Therefore, said lenses are called bifocal lenses. Also known
20 are trifocal and multifocal lenses, both with visible or invisible edge. As it should be apparent, this type of lens partitioning in two or more asymmetrical parts is not feasible in contact lenses, since the lens constantly follows the eye motions, and no relative displacements
25

- 2 -

are possible. While striving to overcome said drawback with contact lenses, a compromise has been made, trying to exploit the capacity of the pupil to adapt to the different light conditions. Therefore, it has been contrived to divide the contact lens in two or more concentric areas having a different degree of spherical curvature, whereby the pupil, when expanding or contracting, can use the different areas, according to the light available, while being supported in this process by the discrimination and synthesis capacity of the brain. However, it has been noticed that said lenses having areas with different spherical curvature gave a blurred vision (for instance split vision) and the eye got easily tired.

The object of this invention is to overcome the above drawbacks by providing contact lenses based on the inventive concept that the central spherical area is designed to provide a perfect far range vision in any light condition, and an optimum near range correction by utilizing the single or plural immediately adjacent concentric areas, having non-spherical progressive curvature. A further important feature of the contact lenses according to this invention is the fact that all corrections are obtained by suitable machining operations of the lens outer surface, both in the neutral and in the

- 3 -

positive and negative lenses.

The near range vision correction mechanism is based on the development of at least an external curve whose dioptric power progressively changes while proceeding in a radial direction from the inside to the outside, said difference in dioptric power from the innermost to the outermost point of the area taken into consideration being given by the algebraic sum of the diopters referred to the two visual defects. The term "progressive" is used herein to indicate that the lens outer surface curvature changes according to a perfect linear progression between the two end values. Said geometrical pattern is obtained by progressively reducing the outer radius, starting from the central spherical area, at a progressive rate and such as to obtain the sagittal of the curve provided for near range correction. The higher is the difference between the far range correction and the near range correction, the faster will be the progression. This type of contact lens may be manufactured by means of numerically controlled lathes, or "duplicating lathes" of any model, and may be applied to any type of material, both hard and soft.

For the purpose of making this invention more easily understood, some definitions of terms currently used in

- 4 -

the art of contact lenses. The definition "base radius" means the radius of the spherical surface facing the eye; the term "sagittal" means the base depth; "optical
5 area" means the diameter of the lens area assigned to vision; the "lenticular radius" is the radius of the connecting curve between the junction point and the lens edge; the term "junction" means the meeting position between two curves, or better the circumference
10 separating two adjacent areas; by the definition "raising at the edge" there is meant the difference between the sagittal of the base curve considered on the lens total diameter, and the final sagittal.

This invention will be disclosed more particularly in
15 the following, based on some embodiments thereof, mentioned herein for exemplary and non limiting purposes, and described by referring to the attached drawing, wherein:

Figure 1 shows schematically a plan view and a diametral
20 cross section of a multifocal positive lens of this invention;

Figure 2 shows schematically a plan view and a cross section of a multifocal negative lens;

Figure 3 is a schematical plan view of a multifocal
25 spherical lens, still according to this invention; and

- 5 -

Figure 4 is a diagram showing schematically, in cross section, the pattern of an inventive lens outer surface, going from the central spherical area to a first adjacent progressive non-spherical area.

As it is shown in Figures 1 to 3, wherein the mutual dimension ratios of the various details are exaggerated for sake of clarity, the lenses according to this invention substantially comprise a central spherical area 1, at least one progressive non-spherical area 2, coaxial and adjacent to the former area, and a peripheral lenticular area 3.

Referring now more particularly to the single Figures 1 to 3, there is reported some examples of input data to the manufacturing lathe control computer, and of output results given in reply by the computer, which are forwarded as control signals for operating said lathe.

Example 1

Manufacturing of a positive multifocal contact lens having a progressive eccentricity.

In a computer connected to a lathe for manufacturing contact lenses, the following values are input: refractive index 1,510; sagittal 2,92 mm; junction thickness 0,15 mm; base curve radius 7,05 mm; dioptrical power 0,00; additional dioptrical power 1,49; diameter of the

- 6 -

optical area 8,00 mm; total diameter 11,50 mm; starting blank total thickness 2,00 mm.

According to a special program, the computer processes
5 the input data and provides in reply the following output results: outer optical curve radius 7,11 mm; central thickness 0,17 mm; raising at the edge 0,03 mm; thickness gauge radius 8,94 mm; arm -4,99 mm; lenticular curve radius 7,01 mm; thickness gauge radius 7,02 mm.
10 The values thus obtained are automatically sent as input data to the lathe which machines the lens outer surface, through carriage displacements.

Figure 1 shows a type of lens manufactured according to this example.

15

Example 2

Manufacturing of a negative multifocal contact lens having a progressive eccentricity.

Following the same procedure as reported in Example 1, the input data to the computer are the following:
20 refractive index 1,510; sagittal 2,92 mm; central thickness 0,06 mm; base curve radius 7,00 mm; dioptrical power -7,00; additional dioptrical power 3,00; radius of the optical area 9,00 mm; total diameter 11,50 mm; starting blank total thickness 2,00 mm.

25 The output values from the computer are: outer optical

- 7 -

curve radius 7,76 mm; raising at the edge 0,08 mm;
thickness gauge radius 9,70 mm; arm -10,32 mm;
lenticular curve radius 6,97 mm; thickness gauge radius
5 6,85 mm. Figure 2 shows an example of the lens obtained
according to the data listed above.

Example 3

Manufacturing of a multifocal progressive eccentricity
contact lens.

10 Following the same procedure as reported in Example 1,
the input data to the computer are the following:
refractive index 1,510; sagittal 2,92 mm; base radius
7,05 mm; dioptrical power -4,49; additional dioptrical
power 4,49; total diameter 11,50 mm; starting blank
15 total thickness 2,00 mm. The following output values are
obtained: optical curve radius 7,55 mm; central thick-
ness 0,10 mm; thickness gauge radius 9,45 mm; arm -3,79
mm. Figure 3 shows an example of a lens obtained accord-
ing to the data listed above.

20 In Figure 4 there is shown schematically the outer
surface pattern of one half of a contact lens according
to this invention, wherein there is pointed out the
linear progression of the non spherical shape of con-
centric area 2, provided for near range vision. Dashed
25 line 4 shows the ideal curvature, starting from the

- 8 -

intersection with the optical axis, of an ideal spherical curve for near range vision, while dashed line 5 shows the pattern, still starting from the intersection with the optical axis, of the ideal curve of a spherical lens provided for far range vision. As it is shown by solid line 2, the actual pattern given to the outer surface of a contact lens according to this invention connects with a progressive deviation the two lines 4 and 5 whereby a progressive non-spherical curvature is obtained. Line 8 is the radius of curvature for far range vision while line 9 is the radius of curvature for near range vision, whereas lines 10 show the progressive radius of curvature variation of the non-spherical area 2, wherein the eccentricity variation of the surface obtained according to the inventive process is in general in the range between 0,01 mm and 0,03 mm for each degree of deviation of the corresponding radius. Double arrow 6 shows the sagittal of the curve provided as above, while double arrow 7 shows the sagittal of the ideal curve 5, relating to far range vision.

The multifocal lenses of the invention having a progressively eccentric and non-spherical curvature provide for a perfect far range vision, in any light condition, and in particular in the case of good light

- 9 -

conditions, as usually available outdoors, whereby the pupil is contracted and covers almost exclusively the lens central area, while the near range vision is

5 ensured, in particular indoors, wherein light conditions are always worse than daylight and the pupil is relatively expanded, by the one or more coaxial areas, adjacent to the central area and having progressive non-spherical curvature, in which case the pupil uses in particular

10 the parallax vision provided by the non-spherical area, also involving the circumfoveal area of the retina. The above features of the contact lenses according to this invention will be particularly valuable for car drivers whose eyes have to watch simultaneously the road

15 (far range vision) and the dashboard instruments (near range vision), since transition from one area of the lens to the other takes place gradually and continuously without the discomfort caused by sudden changes of the dioptrical power.

20 While this invention has been described referring in particular to some particular embodiments thereof, it should be apparent that modifications and/or variations may be made thereto by those skilled in this art, without exceeding the scope of protection of the same

25 invention.

- 10 -

CLAIMS

1. A multifocal contact lens comprising substantially a spherical curvature central area and one or more coaxial adjacent areas, characterized in that the first or single coaxial area adjacent to the spherical curvature central area, has a progressive non-spherical curvature.
2. The multifocal lens of Claim 1, characterized in that said spherical curvature central area is designed for far range vision and at least the first or single coaxial area adjacent to said spherical area is designed for near range vision.
3. The multifocal lens of Claim 1 or 2, characterized in that said different spherical and non-spherical curvatures are obtained through the machining operations of the lens front or outer surface.
4. The multifocal lens of Claim 2, characterized in that the eccentricity variation of said coaxial area adjacent to said central spherical area is in the range of 0,01 to 0,03 mm for each degree of angular displacement.
5. A multifocal lens, substantially as described and shown in the attached drawings.

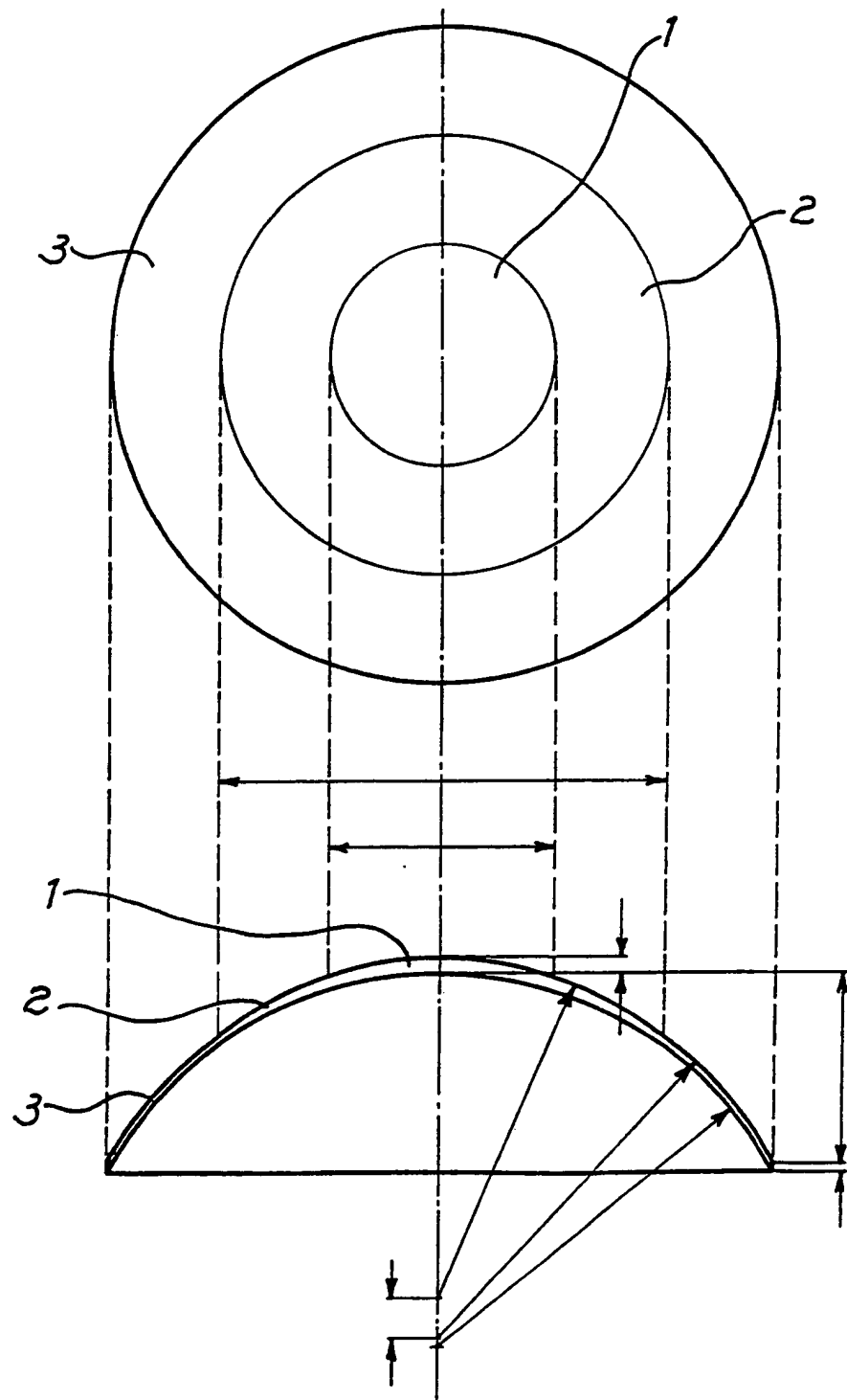
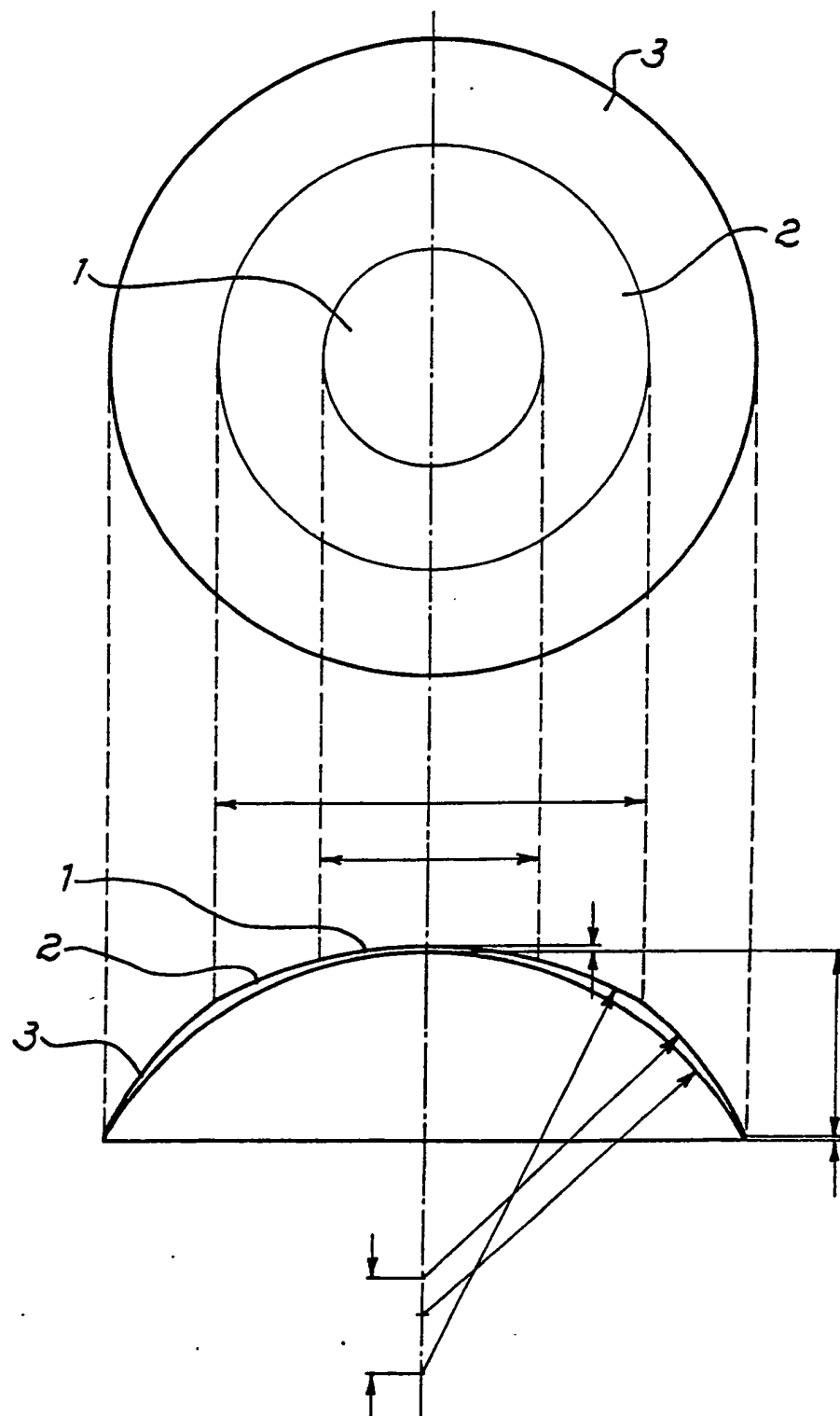
Fig. 1

Fig. 2

- 3 / 4 -

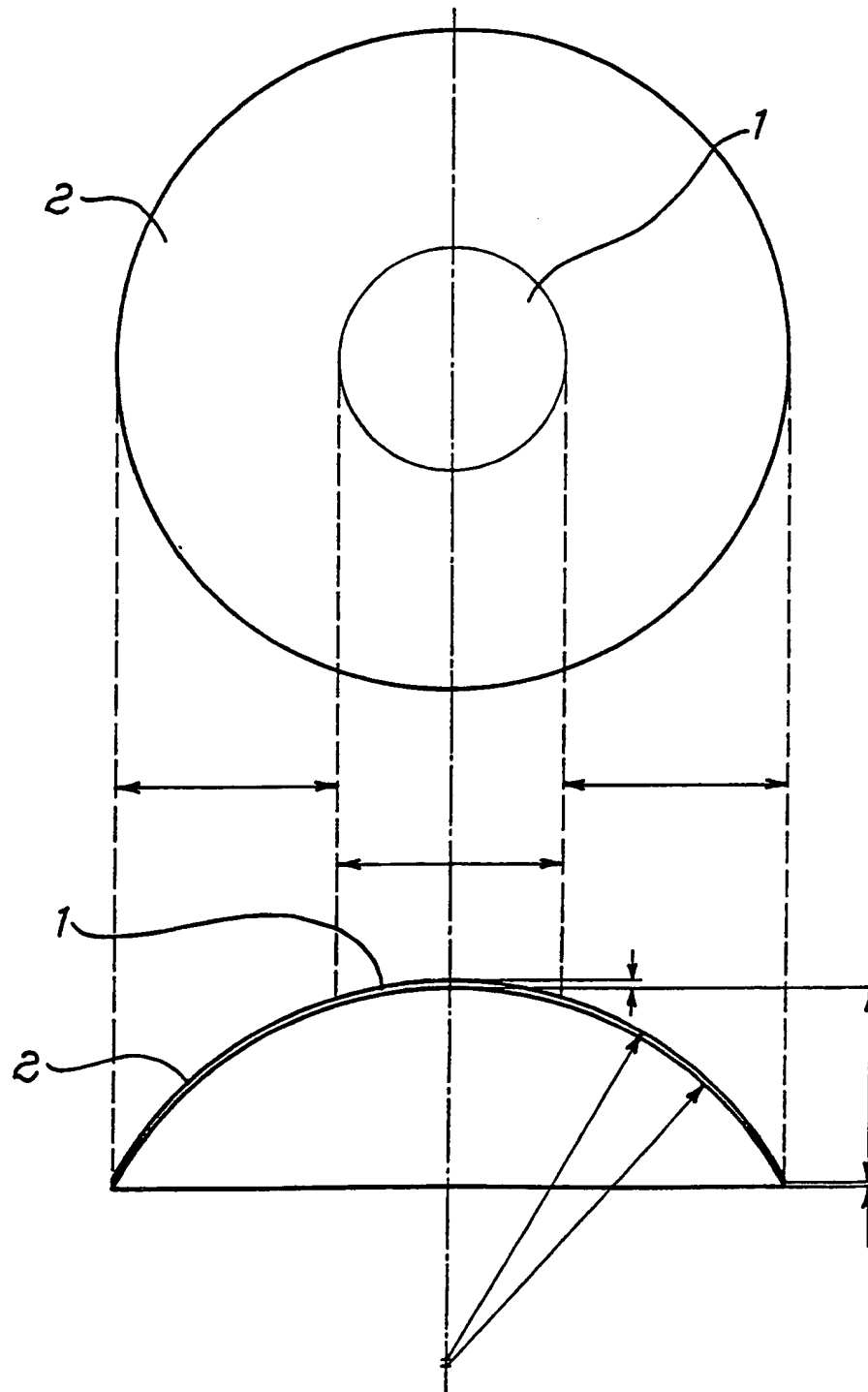
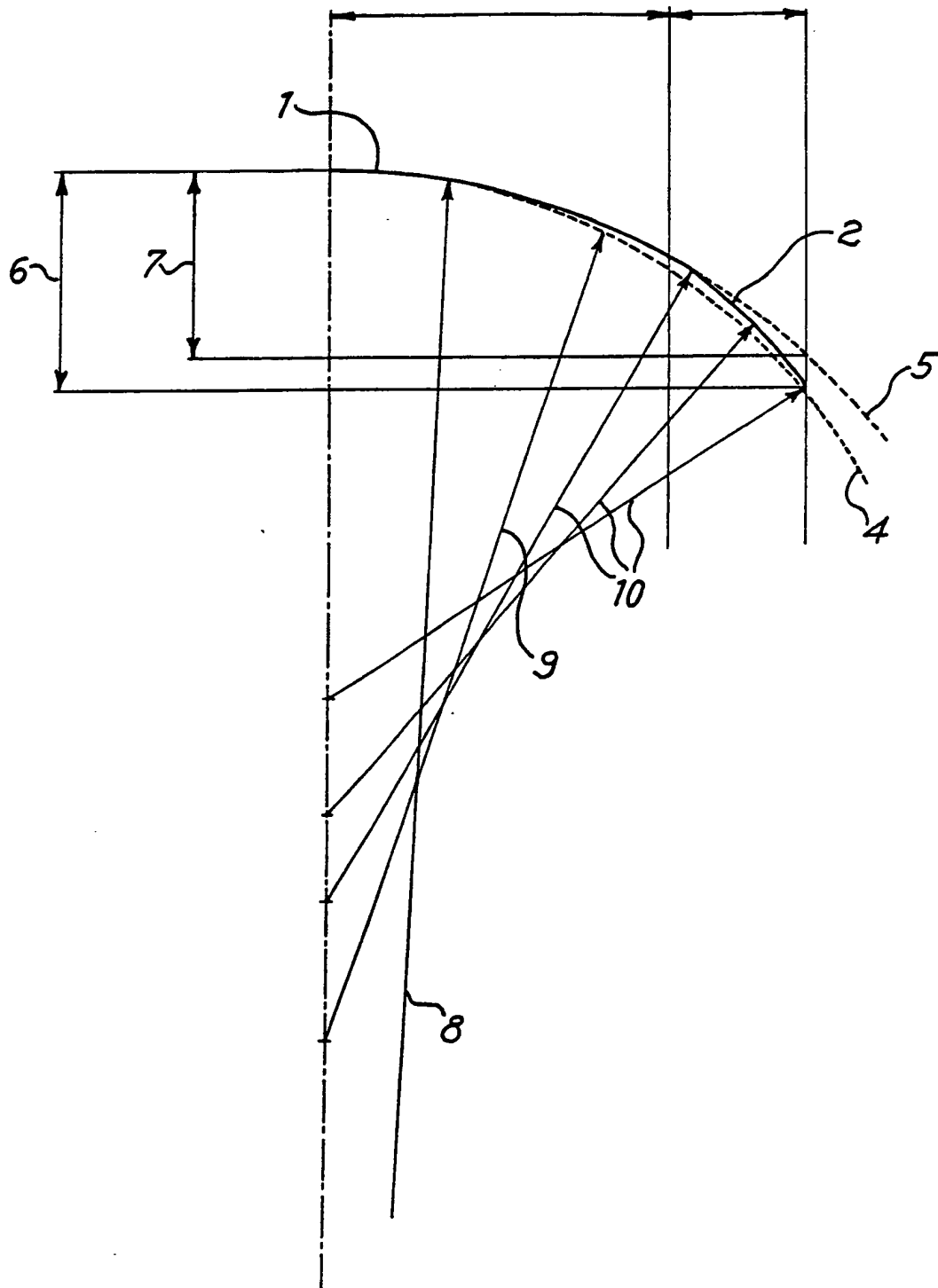
Fig. 3

Fig. 4



INTERNATIONAL SEARCH REPORT

International Application No. **PCT/IT 89/00033**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁴ : G 02 C 7/02, G 02 C 7/04, G 02 C 7/06																							
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">IPC⁴</td> <td style="padding: 5px;">G 02 C 7/02, G 02 C 7/04, G 02 C 7/06</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched⁸</div>			Classification System	Classification Symbols	IPC ⁴	G 02 C 7/02, G 02 C 7/04, G 02 C 7/06																	
Classification System	Classification Symbols																						
IPC ⁴	G 02 C 7/02, G 02 C 7/04, G 02 C 7/06																						
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category¹⁰</th> <th style="border-bottom: 1px solid black;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="border-bottom: 1px solid black;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>EP, A, 0225098 (UNIVERSITY OPTICAL PRODUCTS) 10 June 1987, see abstract; page 1; page 2, lines 1-7 --</td> <td style="text-align: center; vertical-align: top;">1, 2</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>US, A, 4073578 (R.C. WELSH) 14 February 1978, see abstract; column 3, lines 13-68; column 4, lines 1-31 --</td> <td style="text-align: center; vertical-align: top;">1, 4</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>US, A, 4185897 (P.M. FRIEDER) 29 January 1980, see abstract; claims --</td> <td style="text-align: center; vertical-align: top;">1, 3, 4</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>GB, A, 2139375 (B. NUCHMAN) 7 November 1984, see page 1, lines 1-62 --</td> <td style="text-align: center; vertical-align: top;">1-5</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>EP, A, 0201231 (B.A. HOLDEN et al.) 12 November 1986, see abstract --</td> <td style="text-align: center; vertical-align: top;">1-5</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>GB, A, 2086605 (J.L. BREGER) 12 May 1982, see abstract ----</td> <td style="text-align: center; vertical-align: top;">1-5</td> </tr> </tbody> </table>			Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	EP, A, 0225098 (UNIVERSITY OPTICAL PRODUCTS) 10 June 1987, see abstract; page 1; page 2, lines 1-7 --	1, 2	Y	US, A, 4073578 (R.C. WELSH) 14 February 1978, see abstract; column 3, lines 13-68; column 4, lines 1-31 --	1, 4	Y	US, A, 4185897 (P.M. FRIEDER) 29 January 1980, see abstract; claims --	1, 3, 4	A	GB, A, 2139375 (B. NUCHMAN) 7 November 1984, see page 1, lines 1-62 --	1-5	A	EP, A, 0201231 (B.A. HOLDEN et al.) 12 November 1986, see abstract --	1-5	A	GB, A, 2086605 (J.L. BREGER) 12 May 1982, see abstract ----	1-5
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³																					
Y	EP, A, 0225098 (UNIVERSITY OPTICAL PRODUCTS) 10 June 1987, see abstract; page 1; page 2, lines 1-7 --	1, 2																					
Y	US, A, 4073578 (R.C. WELSH) 14 February 1978, see abstract; column 3, lines 13-68; column 4, lines 1-31 --	1, 4																					
Y	US, A, 4185897 (P.M. FRIEDER) 29 January 1980, see abstract; claims --	1, 3, 4																					
A	GB, A, 2139375 (B. NUCHMAN) 7 November 1984, see page 1, lines 1-62 --	1-5																					
A	EP, A, 0201231 (B.A. HOLDEN et al.) 12 November 1986, see abstract --	1-5																					
A	GB, A, 2086605 (J.L. BREGER) 12 May 1982, see abstract ----	1-5																					
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family																					
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center;">19th July 1989</div> </td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center;">11 AUG 1989</div> </td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;"> International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div> </td> <td style="border-bottom: 1px solid black; padding: 5px;"> Signature of Authorized Officer <div style="text-align: center;">M. VAN MOL </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center;">19th July 1989</div>	Date of Mailing of this International Search Report <div style="text-align: center;">11 AUG 1989</div>	International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center;">M. VAN MOL </div>																	
Date of the Actual Completion of the International Search <div style="text-align: center;">19th July 1989</div>	Date of Mailing of this International Search Report <div style="text-align: center;">11 AUG 1989</div>																						
International Searching Authority <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center;">M. VAN MOL </div>																						

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

IT 8900033

SA 28639

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 08/08/89. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0225098	10-06-87	US-A- 4752123	21-06-88
		AU-A- 6445986	21-05-87
		JP-A- 62121419	02-06-87
US-A- 4073578	14-02-78	None	
US-A- 4185897	29-01-80	GB-A- 2040491	28-08-80
GB-A- 2139375	07-11-84	US-A- 4580882	08-04-86
		AU-B- 571217	14-04-88
		AU-A- 2711684	25-10-84
		BE-A- 899476	16-08-84
		CA-A- 1252322	11-04-89
		CH-B- 666559	29-07-88
		DE-A- 3415022	25-10-84
		FR-A- 2544878	26-10-84
		JP-A- 59208524	26-11-84
		LU-A- 85332	26-10-84
		NL-A- 8401293	16-11-84
		SE-A- 8402221	22-10-84
EP-A- 0201231	12-11-86	AU-A- 5705786	06-11-86
		JP-A- 61272717	03-12-86
GB-A- 2086605	12-05-82	AU-A- 7657081	24-06-82
		JP-A- 57105717	01-07-82

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.